

SINK OR SWIM: THE CARTESIAN DIVER

Objective: To investigate how pressure and temperature affect the volume of gases

Materials: 1 liter plastic water bottle and cap
Glass medicine dropper
Large test tube
Marking pencil
2 beakers (400 or 600 ml)
Hot plate
Thermometer
Ice
Stirring rod

Procedure:

1. Fill a clear, colorless 1-liter water bottle with room-temperature tap water.
2. Fill a beaker that is taller than the dropper with water at room temperature. Draw some of the water into the medicine dropper. Place the dropper in the water with the bulb side up and see if it sinks or floats. You want it to float with a very small portion of the bulb above the surface. Adjust the volume of water in the dropper until it does this. Use a marking pencil to mark the resulting water level on the dropper. You will need to dry off the dropper with paper towels first to do this. Be careful not to expel any of the water in the dropper.
3. Remove the dropper from the beaker, taking care to not expel any of the water in the dropper. Place the dropper in the 1-liter bottle with the bulb end towards the mouth of the bottle. Screw the cap onto the bottle tightly.
4. Squeeze the sides of the bottle slowly, and watch the dropper. What happens to the dropper? What happens to the water level inside the dropper? Release the bottle and watch the dropper. Record your observations in the data chart.
5. Remove the dropper from the bottle (you will need to pour out the water to do so, but don't expel the water from inside the dropper)! Place the dropper into a large test tube $\frac{1}{2}$ filled with water. Make sure it still floats.
6. Fill your 400 or 600 ml beaker halfway with water, and then ice, to create a very cold ice water mixture. Place the test tube with the dropper into the ice water mixture. Put a thermometer into the test tube. Watch the water level in the dropper and record your observations. When the temperature has stopped falling, record the temperature and note the water level in the dropper on your data chart.

7. Remove the test tube from the ice water and set the ice water aside. Fill your other beaker about $\frac{1}{2}$ - $\frac{3}{4}$ full of water and place on the hot plate and heat till boiling. Remove the boiling water with beaker tongs and place the beaker on the lab table top. Put the test tube with dropper and thermometer into the hot water, and observe the water level inside the dropper. When the temperature stops rising, record the temperature and note the water level in the dropper on your data chart.
8. Remove the test tube from the hot water and place back into the ice water mixture. Record the temperature and water level in the dropper again on your data chart.

	What happened to water level?	Temperature
Ice water (step 6)		
Hot water (step 7)		
Ice water (step 8)		

QUESTIONS

1. Explain what causes the diver to rise and fall inside the water bottle.
2. What is the relationship between pressure and volume of a gas in the dropper when inside the tightly capped water bottle? Why is it important to keep temperature constant to be sure about your answer?
3. What is the relationship between temperature and gas volume in the dropper when it was in the test tube (i.e. an uncapped container). What quantity is held constant by using an uncapped container? Why is this important?
4. Identify the gas laws used in the lab, and when each law was used.